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(पहला पुनरीक्षण)

Indian Standard

GUIDELINES FOR NON-COKING COALS FOR SOLID REDUCTANT BASED DIRECT REDUCTION IN ROTARY KILNS (AND OTHER REACTORS)

(*First Revision*)

First Reprint FEBRUARY 2001

ICS 75.160.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 1998 **Price Group 1**

Sponge Iron and Smelting Reduction Sectional Committee, MTD 30

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Sponge Iron and Smelting Reduction Sectional Committee had been approved by the Metallurgical Engineering Division Council.

In recent years, sponge iron has gained prominence as a feedstock for steel making in electrical arc furnaces or in oxygen steel making processes. Quality of non-coking coals plays a significant role for the production of sponge iron in rotary kilns. Against this background, it has been considered desirable to formulate this standard so that coals used in sponge iron plants may be chosen as per certain minimum requirements. While formulating these guidelines, the sources and types of non-coking coals generally available in the country have been particularly kept in view. The Committee while reviewing the standard felt this standard be revised taking into consideration the experience gained during the years.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

AMENDMENT NO. 2 APRIL 2007
TO
IS 11860 : 1998 GUIDELINES FOR NON-COKING COALS FOR SOLID REDUCTANT BASED DIRECT REDUCTION IN ROTARY KILNS (AND OTHER REACTORS)

(First Revision)

(*Page* 1, *clause* 4.1, *col* 2, *row* 5) — Substitute '8.0' *for* '4.0'.

(MTD 30)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 1 JANUARY 2004
TO
IS 11860 : 1998 GUIDELINES FOR NON-COKING COALS FOR SOLID REDUCTANT BASED DIRECT REDUCTION IN ROTARY KILNS (AND OTHER REACTORS) —SPECIFICATION

(First Revision)

(*Page* 1, *clause* **4.2**, *line* 5) — Substitute 'comes' *for* 'come'.

(*Page* 1, *clause* **4.2**, *line* 9) — Substitute 'increases' *for* 'increase'.

(*Page* 2, *clause* **6**, *line* 6) —Insert ' ,' after the word 'process'.

(*Page* 2, *clause* **6**, *line* 9) — Substitute 'is' *for* 'are'.

(*Page* 2, *clause* **8.1.1**, *line* 3) — Insert ' ,' after the word 'adopted'.

(MTD 30)

Reprography Unit, BIS, New Delhi, India

Indian Standard

GUIDELINES FOR NON-COKING COALS FOR SOLID REDUCTANT BASED DIRECT REDUCTION IN ROTARY KILNS (AND OTHER REACTORS)

(First Revision)

1 SCOPE

This standard covers the guidelines for non-coking coals for solid reductant based direct reduction (DR) processes in which the reactor is either a rotary kiln or a shaft type in which the reductant is charged directly without gasification in a separate unit.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
1350 (Part 1) : 1984	Methods of test for coal and coke : Proximate analysis (*second revision*)
(Part 2) : 1970	Determination of calorific value (*first revision*)
(Part 3) : 1969	Determination of sulphur (*first revision*)
(Part 4/Sec 1) : 1974	Ultimate analysis, Section 1 Determination of nitrogen (*first revision*)
(Part 5) : 1979	Special impurities (*first revision*)
1353 : 1993	Methods of test for coal carbonization — Caking index, swelling number and (LT) gray-king assay (*first revision*)
1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
11795 : 1996	Guidelines for ash softening studies on solid reductants for direct reduction (*first revision*)
12381 : 1994	Methods of determination of coal reactivity for direct processes (*first revision*)

3 SUPPLY OF MATERIAL

3.1 The material shall be supplied in accordance with the provision of IS 1387.

3.1.1 The important properties of coal for direct reduction include chemical composition, caking characteristics, size of the feed, initial ash softening temperature under mild reducing conditions as well as the reactivity of coal char. The chlorific value and free swelling index may also play important roles.

4 CHEMICAL COMPOSITION

4.1 The non-coking coals for direct reduction should have as low an ash content as possible, as low a sulphur content as possible and a certain minimum amount of volatile matter. Keeping the Indian coal reserves in view, the following chemical composition is suggested:

Constituents	*Percentage (on Dry Basis)*
Ash, *Max*	24
V.M.	25-35
Fixed carbon	By difference in proximate analysis
Sulphur, *Max*	1.0
Inherent moisture, *Max*	4.0

NOTE — Since some coals are suitable as feed coal and some as slinger coals, so slightly wider range has been specified for V.M.

4.2 High ash bearing coals lower the reactor productivity, increase the fuel rate and generally have a deleterious effect on solid reductant based direct reduction processes. For every one percent increase in the ash content of the coal, the productivity come down, at least, by 2 percent in the ash range of 20-30 percent. Coal with very high volatile matter content (that is sub-bituminous and lignite) are somewhat difficult to use because it increase the waste gas volume in addition to the fuel rate adversely.

4.3 The chemical analysis of the coal samples shall be carried out in accordance with the procedure given in the relevant parts of IS 1350.

5 CAKING INDEX

Caking index shall be determined in accordance with IS 1353 and shall be less than 3.

6 SIZE

Coal is fed in most of the direct reduction processes, both from the feed and discharge ends of the reactor. Normally, the size of the feed end coal is coarser than that of the coal blown from the discharge end. The actual size of the two types of coal varies from process to process but in order to reduce the crushing costs, the coal received in any DR plant should be as close of the final size requirements as possible. Commercial coal to –200 mm are normally made available to DR plants. However, the feed coal after crushing would be –25 mm. In addition there is always a limit to the fines (–3 or –1 mm coal), which the sponge iron reactors can tolerate but since it varies from process to process, this has to be mutually agreed to between the purchaser and the supplier to a controlled quantity.

7 MELTING CHARACTERISTICS OF COAL ASH

7.1 The initial softening temperature or initial deformation temperature (IDT), the hemispherical temperature (HST) and the flow point temperature (FT) of the ash in coal under mild reducing conditions play an important role in determining the temperature profile and the maximum temperature which can be tolerated in a DR process. These characteristics shall be determined in accordance with IS 11795.

7.1.1 In general, the minimum initial softening temperature under mild reducing conditions should not be lower than 1 150°C and the desirable value is 1 250°C and higher.

8 REACTIVITY

8.1 The reactivity of coal char is defined as generation of the carbon monoxide per unit mass of coal char (carbon) per unit time under the given experimental conditions.

8.1.1 The reactivity of coal samples shall be determined in accordance with IS 12381. The exact value required shall depend on the process adopted but a minimum reactivity is always necessary in order to ensure satisfactory operation.

8.1.2 Typical acceptable value of coal (char) reactivity and reactivity index would be 1.75 cm^3 of carbon monoxide per gram of carbon per second, minimum and 300 cm^3/minute, minimum respectively as given in IS 12381.

9 CALORIFIC VALUE

9.1 While the calorific value of a given coal is not of direct relevance to the reduction process, it is of significance in calculating the heat input into the process. The gross calorific value and the net calorific value of coal are determined as per the procedure given in IS 1350 (Part 2).

9.1.1 Normally coals having a gross calorific value less than 5 500 kcal/kg cannot be economically used for coal based direct reduction since the productivity of the unit comes down markedly.

10 FREE SWELLING INDEX

10.1 The free swelling index of a coal is used for immediate rejection or acceptance of the coal sample for use in sponge iron production. It is a measure of how the coal swells during evolution of volatile matter. Coals whose free swelling indices exceed one, can be straightway rejected.

10.1.1 The swelling index shall be determined as per the procedure given in IS 1353.

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This Indian Standard has been developed from Doc : No. MTD 30 (3981).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Printograph, New Delhi, Ph : 5726847